Puget Sound Nutrient Modeling

Nutrient pollution is **considered** one of the largest threats to Puget Sound. Recognized nation-wide, these characteristics of nitrogen pollution apply equally and imperatively to Puget Sound (Howarth, 2006):

- Human acceleration of the nitrogen cycle over the past 40 years is far more rapid than almost any other aspect of global change.
- Nutrient pollution leads to hypoxia and anoxia, degradation of habitat quality, loss of biotic diversity, and increased harmful algal blooms.
- Technical solutions exist and should be implemented, but further research can best target problems and solutions, leading to more cost effective solutions.
- Current monitoring programs are not adequate to provide needed information into the future.

This proposal lays out a scientific plan to address nitrogen pollution in Puget Sound, to complement associated regulatory and management initiatives.

Project Objectives

1. Establish Puget-Sound-wide "community models" at three scales for multiple uses; improve coordination of Puget Sound Modeling work.
2. Use the models established above to answer the following nutrient management questions:

   - Are current nitrogen loadings from point and nonpoint sources in and around Puget Sound significantly impacting water quality at a large scale?

   - What nutrient reductions are necessary to reduce or eliminate human impacts to biomass and dissolved oxygen levels in sensitive embayments?

Project Description

This project consists of four parts:

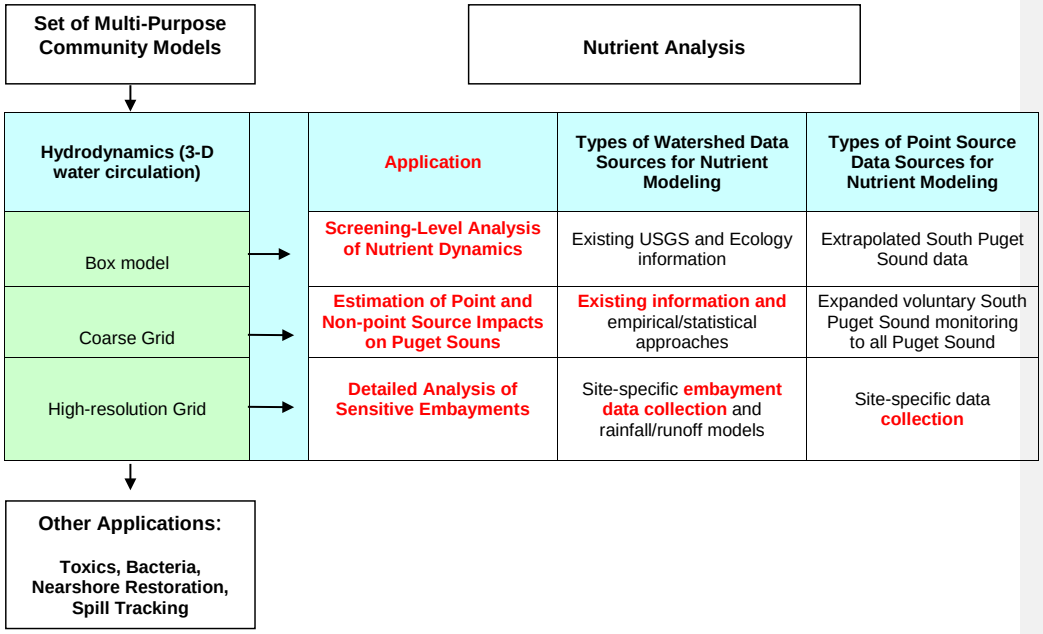
I. Establish a set of multi-purpose hydrodynamic "community models" for the entire Puget Sound at three scales, fine, intermediate, and large, that can be used as common tools by a variety of organizations for a variety of purposes. Enhance model coordination through information sharing and providing common tools. This work will be done by contractual agreement by the Pacific Northwest National Laboratory, building on extensive work already completed.

II. The large-scale model (also called "box model") will be used by Ecology to do a screening-level evaluation of nutrient effects on dissolved oxygen, Puget-Sound-wide. The results of this effort will inform the more detailed work below.

III. The intermediate-scale model (also called "coarse model") will be used by Ecology to evaluate the effect of human-caused nutrient enrichment on dissolved oxygen across Puget Sound. This model will inform potential Puget-sound-wide management strategies and decisions.

IV. The fine-scale model (also called "detailed model") will be used for site-specific studies, including Total Maximum Daily Load or related studies in critical areas with known dissolved oxygen problems. This model can also be used to evaluate potential causes of nuisance algae, such as excess beach sea lettuce accumulating on beaches, by differentiating the local (tributary) vs greater Puget Sound contributions of nutrients.

The chart below shows the three scales of models and the water quality information to be used for nutrient modeling at each scale.



Project Tasks

I. Set of Community Models and Enhanced Model Coordination

1. Work with Pacific Northwest National Laboratories (PNNL) to develop a set of hydrodynamic models at three scales for the entire Puget Sound that could be used by a variety of organizations for a variety of purposes. Steps include: model selection, development, and **corroboration with available data and** ~~verification against~~ available models for smaller geographic areas, such as the South Puget Sound water quality model.

2. Set up a Puget Sound modeling website that includes documentation of the three models and facilitates information sharing and coordination of modeling efforts. The Puget Sound Marine Environmental Modeling Consortium (PSMEM-C) will be used to identify opportunities for enhancing model coordination.

II. Box Nutrient Model (Large Scale)

1. Use the large-scale hydrodynamic box model as a base **for a water quality model that simulates the impact of nutrients on phytoplankton and dissolved oxygen**.
2. Using existing information on tributary and point-source loading of nutrients to Puget Sound, develop a water quality model to make preliminary findings on the effect of dissolved oxygen across the sound. Results will show critical areas and times and provide boundary conditions, initial conditions, and parameter estimates for the next level of analysis (below).

III. Coarse Puget-Sound-Wide Nutrient Model

1. Use the intermediate-scale hydrodynamic model as a base **for a water quality model that simulates the impact of nutrients on phytoplankton and dissolved oxygen**.
2. Develop estimates of current nutrient loading to Puget Sound based on existing data and statistical/empirical approaches.
3. Develop estimates of current point-source nutrient loading based on extrapolating results from the South Puget Sound study.
4. Develop water quality model for making management decisions. Also provides boundary conditions, initial conditions, and parameter estimates for detailed basin-specific studies (below).

IV. Detailed Nutrient Studies

1. Continue existing work in developing basin-specific TMDL studies. Current focus is on South Puget Sound; next area of focus is likely Whidbey Basin. This proposal includes writing a Quality Assurance Project Plan for the next basin-specific TMDL.

Outcomes

- Set of Puget Sound-wide models at three scales for multiple uses and improved Puget Sound modeling coordination.
- Quantitative information on dissolved oxygen impairments due to excess nutrients to support Ecology's nutrient management decisions at both a regional and site-specific scale.

Budget

I. Set of Community Models and Web Site	
• Definition of model selection criteria, Project and Contract Management, Evaluation of Model Performance	$ 50,000
• **Model Development and Support (Contract with Pacific Northwest Laboratories)**	$220,000
II. Box Model (Large Scale)	
• Expand to entire Puget Sound if feasible	$ 50,000
• Data Compilation, Analysis, and Report	$ 50,000
III. Coarse Model	
• Data Compilation, **Model Refinement**, Analysis, and Report	$200,000
• Equipment (computer cluster)	$ 30,000
IV. Fine-Scale Model	
• Confirm fine-scale water quality model by comparing output to **available data and**	$ 50,000

Commented [b1]: I'm curious about this one…is this necessary?

Commented [b2]: Does the plan need to be more clear on breakdown of work between PNNL and Ecology?

South Puget Sound **model** results
- QAPP for the next TMDL Study (possibly Whidbey Basin $ 40,000

Total $690,000

Schedule

Parts I- III: July 1, 2008 – June 30, 2009
Part IV: July 1, 2009 – June 30, 2010

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References

Howarth, R., 2006. From presentation to the White House Office of Science and Technology Policy by Robert W. Howarth, *David R. Atkinson* Professor of Ecology & Environmental Biology, Cornell University, November 3, 2006.